Management Strategy Evaluation: update

Agenda Item 10.1

(IPHC-2019-AM095-12)
Management Strategy Evaluation (MSE)

a process to evaluate harvest strategies and develop a management procedure that is robust to uncertainty and meets defined objectives
Primary Biological objectives

1.1. The primary objective is to avoid a critical biomass below which the stock may not recover

- No more than a 10% risk of being below
- 20% of the dynamic unfished equilibrium biomass
- Long-term (and short-term is of interest)

<table>
<thead>
<tr>
<th>Time-frame</th>
<th>Tolerance</th>
<th>Measurable Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short-term: 4-13 years</td>
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<tr>
<td>Medium-term: 14-23 years</td>
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<tr>
<td>Long-term: Equilibrium</td>
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Primary Fishery objectives

2.1. Limit annual changes in the TCEY
   – No more than a 25% risk of being above
   – 15% Average Annual Variability (AAV)
   – Short-term (and long-term is of interest)

2.2. Maintain a minimum TCEY
   – Not sure of a minimum or a tolerance

2.3. Maximize TCEY subject to above
Prioritized objectives

- Must meet long-term Biological Sustainability (1.1)
- Then meet short-term catch limit stability (2.1) and maintain a minimum catch limit (2.2)
- Then maximize short-term fishery yield subject to above

- Additional metrics can also be informative
  - For example. P(SB<30%), median AAV, or quantiles
Management Procedure

Key to shapes and colors
- Science Input
- Management Input
- Output
- Recommendation
- Decisions

Harvest Strategy Policy

SCALE
- Coastwide Assessment
- Fishing Intensity ($F_{SPRM40}$)
- Total Mortality

TCEY DISTRIBUTION
- TCEY (O26)
- Stock Distribution
- U26 Mortality
- Distribution Procedures

DECISION
- Mortality Table
- Decision Table
- CB PAB SRB
- COMMISSION
- REGULATORY AREA MORTALITY LIMITS (TCEY)
Scale Management Procedure

Harvest Control Rule

- SPR (Spawning Potential Remaining)
- Increasing Fishing Intensity
- SPR = 0%
- SPR = 100%
- No Directed Fishery
- Fishery Limit (10%, 20%)
- Fishery Trigger (25%)
- Maximum Fishing Intensity (Procedural SPR) 30%-56%
- Biomass (dRSB)
Closed-loop simulation framework

Cannot control

Operating Model

Population
- Stock dynamics
- Parameters
- Variability

Actual Removals

Total Mortality

Fisheries
- Dynamics
- Availability
- Variability

Can control

Management Procedure

Simulated Estimation Error

Harvest Rule
- Procedural SPR
- Fishery Trigger/Limit
- Constrain TCEY change

Annual Process
Simulation Results: Performance metrics

• Three performance metrics

  1. dRSB: dynamic relative spawning biomass, long-term
     • An appropriate measure of stock status
     • Avoid going below 20% more than 10% of the time

  2. AAV: average annual variability, medium-term
     • Average percent change in TM limit from year to year
     • Avoid going above 15% more than 25% of the time

  3. TM: total mortality limit
     • Maximize the median value
**Performance metrics (40:20 & 30:20 CRs)**

- Bio objective satisfied for all procedures
- AAV objective not satisfied for all procedures
- Median TM increases slightly and range increases with FI
• Bio objective satisfied for all procedures
• AAV objective not satisfied for all procedures (but lower)
• Median TM slightly higher for 25:10 CR
Constrained Management Procedures

- Max Change
  - TM limit constrained to change no more than 15%
- Slow-Up, Fast- or Full-Down
  - TM limit constrained to increase or decrease less than the full Management Procedure outcome
- Cap
  - TM limit cannot exceed a maximum (60 Mlb or 80 Mlb)
- Multi-year
  - Set the TM limit every third year

All use a 30:20 control rule
Constrained Management Procedures

All use a 30:20 control rule
- Bio objective satisfied by all
- AAV reduced
- Slight potential for lost yield
Constrained MPs

• Max Change
  – Has potential and able to meet all objectives

• Slow-up, fast or full down
  – Has potential and able to meet all objectives

• Caps
  – Reduced AAV when stock at high levels, but not at low levels
  – Does not take advantage of very high yield opportunities

• Multi-year
  – Has potential and able to meet all objectives for SPR>40%
  – The change every 3rd year is 27%, on average, for SPR=46%
    • Compared to 25% for every 3rd year when setting an annual limit
Scale evaluation summary

- All MPs met the long-term biological sustainability objective
  - Short-term biological risks were greater and many MPs showed a greater risk than tolerable (>10%)
- Only some constrained MPs met the variability objective in the medium-term
  - maxChangeBoth, slow-up fast-down, and MultiYear
- Median TM differed slightly between MPs
  - peaked around SPR=40%, and showed a wide range
• Some additional investigation of MP’s may be useful
• A constraint may increase conservation risk, but would reduce variability in the mortality limit
• At SPR values lower than 40% (higher Fishing Intensity)
  – median mortality limit showed minimal increase
  – the variability in the mortality limit increased more quickly
  – The highest ranked MP was SPR=40%, 30:20 CR, maxChange=15%
Application of a Management Procedure

- Implement a MP as part of a harvest strategy policy
  - For example, the reference SPR in the decision table
Some discussion at the MSAB meeting was about being comfortable keeping the stock around a specific biomass – An unstated biological objective – The draft Harvest Strategy Policy states an objective to maintain the biomass at levels, on average, that produce maximum net economic returns

### Additional Objectives

<table>
<thead>
<tr>
<th>SPR</th>
<th>56%</th>
<th>46%</th>
<th>40%</th>
<th>36%</th>
<th>30%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median relative biomass</td>
<td>49%</td>
<td>41%</td>
<td>36%</td>
<td>32%</td>
<td>27%</td>
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Program of Work

AM095 (2019): Results on Scale
AM096 (2020): Update on Distribution and Scale
AM097 (2021): Results on Distribution and Scale
A procedure for distributing the TCEY (1)

Coastwide Target Fishing Intensity

- Determine coastwide Total Mortality from Scale MP
- Separate TM into O26 (TCEY) and U26 components
Regional Stock Distribution

- Distribute the coastwide TCEY to biologically-based Regions
  - Use proportion of the stock estimated in each Region for “all sizes”
    WPUE index from IPHC fishery-independent setline survey
- Biological Sustainability objectives
Regional Allocation Adjustment

• Adjust the distribution of the TCEY among Regions
  – For example, use relative target harvest rates by Region
• Biological Sustainability and Fishery objectives
Regulatory Area Allocation

- Apply allocation percentages for each Regulatory Area within a Region
- Based on policy, data, observations, or agreement
- Fishery objectives

A procedure for distributing the TCEY (4)
Distributing the TCEY

- Coastwide target fishing intensity
- Regional Stock Distribution
- Regional Allocation Adjustment
- Regulatory Area Allocation
Annual Regulatory Area Adjustment

• Adjust Regulatory Area TCEY’s to account for other factors as needed
• Policy part of the harvest strategy policy
• May deviate from the management procedure
  – Will have unpredictable consequences
Recommendations

- **ENDORSE** the primary objectives and associated performance metrics
- **RECOMMEND** additional goals and objectives
  - Minimum Total Mortality Limit (Objective 2.2)
  - Objective related to a target biomass
- **RECOMMEND** a management procedure for the Scale portion of the harvest strategy be adopted in the interim
  - An SPR of XX% with a fishery trigger of XX% and a fishery limit of XX%
  - An annual constraint of XX%
- **RECOMMEND** additional Scale MPs to evaluate in 2019 using the coastwide framework
  - SPR values of XX%, Fishery trigger values of XX%, Fishery limit values of XX%
  - Constraints in the form of XX
- **RECOMMEND** using the distribution framework for evaluation
MSE Explorer

- View the results and make comparisons
- Create tables that can be downloaded
  - Create plots that can be saved
